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ANALYSIS AND DISCUSSION
OF
SCHOOL LIGHTING

NEW ORLEANS PUBLIC SERVICE INC.

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ANALYSIS AND DISCUSSION

OF

SCHOOL LIGHTING

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Submitted By _____
Sales Engineer

Approved By _____
Manager

New Orleans Public Service Inc.
Industrial & Commercial Sales Division

AMERICAN AIR FORCE

GENERAL INVESTIGATION

Submitted by

Approved by

The Office of the Director of the
Department of the Army, Washington, D.C.

ANALYSIS AND DISCUSSION

OF

SCHOOL LIGHTING

EYESIGHT CONSERVATION:

Conservation of eyesight of children is one of the major problems of education today. With the beginning of school, all children's eyes start on the road of close visual application which carries on through the rest of their lives, and the health and progress of school children are largely dependent upon working conditions and environment provided in the school classrooms.

Six million school children are retarded each year in the United States. Of this number, the Eyesight Conservation Council estimated that one-third are retarded because eyesight is neglected, because lighting is inadequate.

OUTDOOR EYES:

Human eyes - accustomed for countless centuries to casual, long distance seeing out-of-doors, in high intensities of daylight - are still outdoor eyes. Yet in a few short generations, we have become a race of indoor workers (see following illustration). With artificial light we have doubled our seeing hours. School work involving prolonged visual tasks is done indoors with only a small fraction of the outdoor light our eyes were made for (see following illustration).

LIGHTING AND EDUCATION:

Today, thousands of students are required to study in classrooms under less than one per cent of the illumination found outdoors in the shade of a tree, and the shade of a tree is a comfortable place in which to read or work, from the standpoint of lighting.

A recent scientific study of the relation of artificial lighting to vision has disclosed some startling information. It was found that the eye, which can see perfectly under 10,000 footcandles of sunlight, can also see under 1/200 of one footcandle, as provided by a full moon. The eye, then, can make radical adaptations, and eyestrain does not show itself in permanent injury over short periods of time. The human eye cannot determine when it is being called upon to function under improper lighting conditions. Weeks or months of such abuse will manifest itself in headaches, nervousness, unnecessary bodily fatigue, and failures in school work.

ANNEX 1 - THE DOCUMENT

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GENERAL PRINCIPLES

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Development of agriculture is one of the most important of economic tasks. With the beginning of modern agriculture, the world has seen a rapid increase in the production of food and other agricultural products. This increase has been the result of many factors, including the use of modern machinery, the application of scientific principles, and the development of new breeds of animals and plants. The result has been a steady increase in the world's food supply, which has enabled the world's population to grow from about 1 billion in 1800 to over 3 billion today.

It is important to note that the development of agriculture is not a purely technical matter. It is also a social and economic one. The way in which agriculture is developed can have a profound effect on the lives of the people who live in the area. For example, the use of modern machinery can lead to the displacement of many people who are employed in the traditional methods of agriculture. Therefore, it is essential that the development of agriculture be carried out in a way that takes into account the needs and interests of the people who are affected by it.

GENERAL PRINCIPLES

There are a number of general principles which should be followed in the development of agriculture. These principles are: 1. The use of modern machinery and equipment. 2. The application of scientific principles. 3. The development of new breeds of animals and plants. 4. The use of modern methods of irrigation. 5. The use of modern methods of fertilization. 6. The use of modern methods of pest control. 7. The use of modern methods of storage and transport. 8. The use of modern methods of marketing. 9. The use of modern methods of financing. 10. The use of modern methods of education. These principles are not mutually exclusive, and many of them can be applied together. For example, the use of modern machinery and equipment can be combined with the application of scientific principles to develop new breeds of animals and plants. Similarly, the use of modern methods of irrigation can be combined with the use of modern methods of fertilization to increase the productivity of the land.

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Eyes Are Not Being Used Today As Nature Intended

Nature's Plan—OUTDOORS

Distant, Relaxed Vision

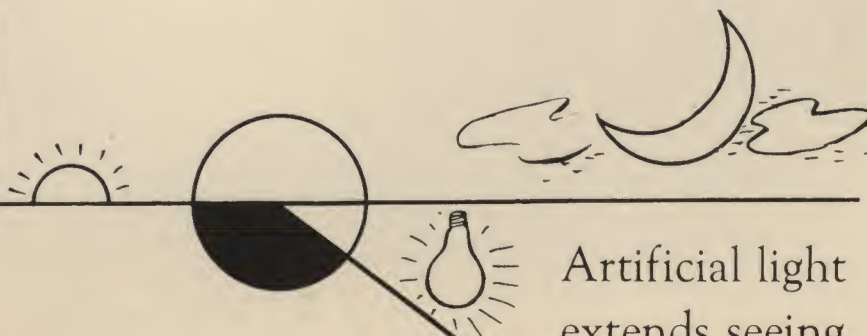


Eyes used only during
daylight hours.

Man's Plan—INDOORS



Close, concentrated
seeing.



Artificial light
extends seeing
long after
dark.

● EYES were designed for *Outdoor Seeing*

SUNLIGHT



10,000
footcandles



SHADE



1,000
footcandles



● AVERAGE
OFFICE



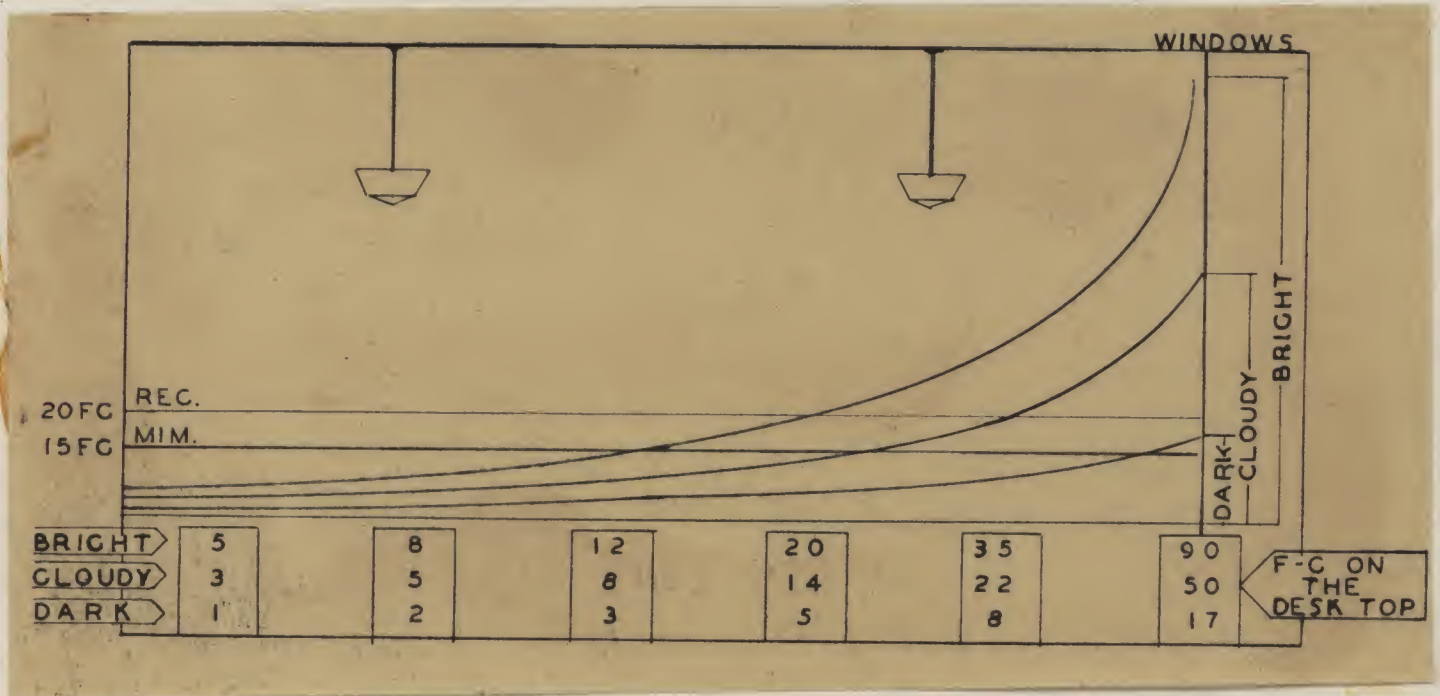
5 to 10
footcandles



DAYLIGHTING IN SCHOOLS:

Since most schools are in operation principally during the daylight hours, it seems logical to assume that little or no artificial light is necessary in classrooms where windows are plentiful. Such is rarely the case, however, even in the most modern schools where window areas have been carefully regulated and school buildings most advantageously oriented to receive the greatest possible amount of daylight.

DISTRIBUTION OF DAYLIGHT ACROSS A TYPICAL CLASSROOM CURVES SHOW READINGS IN FOOTCANDLES



It will be noted from the above chart that even on a bright day the far side of the classroom, away from the windows, is inadequately lighted when dependent upon natural illumination alone. On a cloudy day, practically the entire room requires supplementary artificial illumination. The above findings is the result of actual school surveys made here in the city of New Orleans.

During two-thirds of the school year, fifty per cent of the daylight hours are cloudy according to records of the New Orleans office of the United States Weather Bureau. See following table:

1952-53
The following information was obtained from the records of the
Department of the Interior, Bureau of Land Management, and is
being furnished to you for your information.

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RECORDS OF THE DEPARTMENT OF THE INTERIOR, BUREAU OF LAND MANAGEMENT

1952-53
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PERCENTAGE OF CLOUDY HOURS
SUNRISE TO SUNSET

OCTOBER	41 %
NOVEMBER	47 %
DECEMBER	58 %
JANUARY	56.5 %
FEBRUARY	55.5 %
MARCH	52 %

THESE FIGURES ARE BASED ON RECORDS OF THE NEW ORLEANS
OFFICE OF U. S. WEATHER BUREAU FOR THE PAST 67 YEARS

There is an insufficient amount of light over half of the classrooms even on a bright sunny day, but 50% of the daylight hours are cloudy, so we can readily see how good artificial illumination is absolutely necessary to provide safe seeing conditions in the classroom.

Daylight, therefore, is variable and cannot be depended upon to provide adequate illumination. All children cannot be seated near the window side of the room, yet only near windows is daylight available of sufficient intensity for proper seeing. The solution of the problem, then, lies in supplementing daylight with artificial lighting in order to reduce to a minimum great variations in the level, in the color, and the direction of light which naturally occurs due to the movement of the sun from hour to hour.

ARTIFICIAL LIGHTING IN SCHOOLS:

After every precaution has been made to utilize daylight to the best advantage, the next step necessary to give any school adequate light and every pupil an equal chance in the pursuit of knowledge and in the prevention of ocular fatigue is the installation of an adequate system of artificial lighting.

A well planned lighting system attempts to obtain a practically uniform level of illumination throughout the room so that no desk position is favored over another as far as the amount of light supplied is concerned. This uniformity of illumination is a matter of proper spacing of lighting units regardless of the size of the lamp which

they burn. Because of the fairly standardized sizes of classrooms, the number of units can likewise be standardized, the normal size classroom requiring six fixtures.

School lighting is prescribed and appraised in terms of quantity and quality. Quantitatively, lighting is measured in terms of footcandles, or units of illumination. Having enough illumination is probably the most important thing to be considered in lighting. Quality of light takes into account brightness of light source, presence of shadows, and illumination of the room surroundings in contrast with the light on the work.

Reba F. Harris, Associate Director, Bureau of Public Health Education of the Kentucky State Department of Health, says, "Authoritative sources point to the fact that approximately 87% of all the impressions which reach the brain go through the eye". In other words, seeing accounts for the majority of the learning imparted to the pupil.

The following facts which have been proved by years of careful research, and demonstrated in practice, show how better light helps in solving the "seeing" problem:

UNDER ADEQUATE ILLUMINATION

<u>Size</u>	- Small objects can be seen more easily. (Light acts as a magnifier of small detail)
<u>Contrast</u>	- Details of low contrast become more discernible. (Sewing with dark thread on dark material illustrates a task with very low contrast.)
<u>Brightness</u>	- Dark objects become more easily visible as the amount of light is increased.
<u>Time</u>	- We see more quickly. (Light increases speed of vision.)
<u>Near Vision</u>	- Fatigue of the eye muscles is reduced as less energy is expended. (Also, we do not need to hold work closer than elbow distance to see.)
<u>Extent of Use</u>	- Strain from long hours of eye use is lessened. (Better light means more efficient seeing.)

PROOF:

When a student fails a grade, an extra financial burden must be assumed by the community and society in general. It is definitely an established fact that adequate school lighting reduces failures as brought out in the tests conducted in the Tuscumbia (Alabama) City School.

For this test arrangements were made for two adjacent rooms having the same physical dimensions and the same orientation. Two sections of the Sixth Grade were selected, and two teachers, who employed the same teaching methods, were assigned to do departmental work between the two classes, each teaching certain subjects in both sections. All the pupils of the Sixth Grade were required to submit to the Otis Self-Administered Test of Mental Ability and the Standard Achievement Test, and were divided equally according to the results of the tests.

The following table shows the results of the tests conducted over a three year period:

School Year	Number of Pupils in		Number of Failures in		Ratio Failures To Enrollment	
	Room "A"*	Room "B"*	Room "A"*	Room "B"*	Room "A"*	Room "B"*
1930-31	34	26	11	4	per cent 32.3	per cent 11.2
1931-32	42	42	11	3	26.2	7.1
1932-33	39	34	7	2	17.9	5.9
Total years	115	112	28	9	-	-
Av. per year	38	34	9	3	23.7	8.3

* Room "A" - Poorly lighted.
Room "B" - Properly lighted.

It will be noted from this table that there were two-thirds fewer failures in room "B", the properly lighted room. In addition to the reduced failures, the teachers testified, "The children in room "B" were much more alert, cheerful, and attentive, while those in room "A" seemed restless and sleepy on dark days and were harder to teach".

Another similar study was conducted at Mount Lebanon, Pennsylvania. The data indicated a 28% greater gain in educational age in the better lighted room.

In Cambridge, Massachusetts, a psychologist assisted by a statistician conducted a test that showed a 10% greater achievement and a 28% greater gain in reading age, coupled with two-thirds fewer failures in the better lighted rooms.

VAN WERT, OHIO, TEST

U. E. Diener, Superintendent of Schools in Van Wert, Ohio, says that he is firmly and unalterably convinced that the new illumination installed in his schools has released an abundance of physical and nervous energy for school tasks that was formerly burned up on the same tasks because of inadequate light. He is completely satisfied with the lighting, and in his opinion, the school board has never spent any money that will yield as large return as this improvement.

A recapitulation of the statistical results of the test conducted at the Van Wert High School, both before and after the lighting change is shown below:

VAN WERT HIGH SCHOOL

Grades of Pupils	Before Lighting Change	After Lighting Change	% of Increase or Decrease
	Base Years 1935 - 1937	Years 1937 - 1938	
	Enrollment - 2,305	Enrollment - 2,368	
	<u>% of No.</u>	<u>% of No.</u>	
A	8.85	9.53	7.68 Increase
B	24.64	24.25	1.62 Decrease
C	38.83	42.05	8.29 Increase
D	22.95	20.11	12.38 Decrease
F	4.73	4.07	13.95 Decrease

Note: - The above data on subject grades include only subjects requiring classroom preparation. Subjects such as music, gym, etc. are not included. Total enrollment means subject enrollment. To obtain pupil enrollment divide by four.

Mr. Diener states, "I cannot help being mercenary enough to convert this decrease in pupils' failures, the "F's", for there is where the repetition of subjects occurs, to a dollars and cents basis."

Before Change: 4.73 of 2305 = 109.0265 - Subject Failures
After Change: 13.95 of 109.0265 = 15.2 - less Subject Failures

Mr. Diener adds, "If we assume \$20.00 per subject as the average cost, then 15.2 x 20 equals \$304.00 per semester savings in teaching cost on repeating failing subjects, or \$608.00 per year for the first year. It is only fair to assume that this percentage of increase may grow."

That eye defect correction and better lighting are of value as educational aids is amply proved by the acceptance of complete eye care and the use of higher levels of illumination for sight-saving pupils.

THE NEW YORK PUBLIC LIBRARY

It is the purpose of this report to present a summary of the results of the study of the New York Public Library, and to show the progress made in the various departments of the library during the year 1917. The study was made by the Library Committee, and the results are presented in this report. The study was made by the Library Committee, and the results are presented in this report. The study was made by the Library Committee, and the results are presented in this report.

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THE NEW YORK PUBLIC LIBRARY

Year	1917	1916	1915	1914	1913	1912	1911	1910	1909	1908	1907	1906	1905	1904	1903	1902	1901	1900	1899	1898	1897	1896	1895	1894	1893	1892	1891	1890	1889	1888	1887	1886	1885	1884	1883	1882	1881	1880	1879	1878	1877	1876	1875	1874	1873	1872	1871	1870	1869	1868	1867	1866	1865	1864	1863	1862	1861	1860	1859	1858	1857	1856	1855	1854	1853	1852	1851	1850	1849	1848	1847	1846	1845	1844	1843	1842	1841	1840	1839	1838	1837	1836	1835	1834	1833	1832	1831	1830	1829	1828	1827	1826	1825	1824	1823	1822	1821	1820	1819	1818	1817	1816	1815	1814	1813	1812	1811	1810	1809	1808	1807	1806	1805	1804	1803	1802	1801	1800	1799	1798	1797	1796	1795	1794	1793	1792	1791	1790	1789	1788	1787	1786	1785	1784	1783	1782	1781	1780	1779	1778	1777	1776	1775	1774	1773	1772	1771	1770	1769	1768	1767	1766	1765	1764	1763	1762	1761	1760	1759	1758	1757	1756	1755	1754	1753	1752	1751	1750	1749	1748	1747	1746	1745	1744	1743	1742	1741	1740	1739	1738	1737	1736	1735	1734	1733	1732	1731	1730	1729	1728	1727	1726	1725	1724	1723	1722	1721	1720	1719	1718	1717	1716	1715	1714	1713	1712	1711	1710	1709	1708	1707	1706	1705	1704	1703	1702	1701	1700	1699	1698	1697	1696	1695	1694	1693	1692	1691	1690	1689	1688	1687	1686	1685	1684	1683	1682	1681	1680	1679	1678	1677	1676	1675	1674	1673	1672	1671	1670	1669	1668	1667	1666	1665	1664	1663	1662	1661	1660	1659	1658	1657	1656	1655	1654	1653	1652	1651	1650	1649	1648	1647	1646	1645	1644	1643	1642	1641	1640	1639	1638	1637	1636	1635	1634	1633	1632	1631	1630	1629	1628	1627	1626	1625	1624	1623	1622	1621	1620	1619	1618	1617	1616	1615	1614	1613	1612	1611	1610	1609	1608	1607	1606	1605	1604	1603	1602	1601	1600	1599	1598	1597	1596	1595	1594	1593	1592	1591	1590	1589	1588	1587	1586	1585	1584	1583	1582	1581	1580	1579	1578	1577	1576	1575	1574	1573	1572	1571	1570	1569	1568	1567	1566	1565	1564	1563	1562	1561	1560	1559	1558	1557	1556	1555	1554	1553	1552	1551	1550	1549	1548	1547	1546	1545	1544	1543	1542	1541	1540	1539	1538	1537	1536	1535	1534	1533	1532	1531	1530	1529	1528	1527	1526	1525	1524	1523	1522	1521	1520	1519	1518	1517	1516	1515	1514	1513	1512	1511	1510	1509	1508	1507	1506	1505	1504	1503	1502	1501	1500	1499	1498	1497	1496	1495	1494	1493	1492	1491	1490	1489	1488	1487	1486	1485	1484	1483	1482	1481	1480	1479	1478	1477	1476	1475	1474	1473	1472	1471	1470	1469	1468	1467	1466	1465	1464	1463	1462	1461	1460	1459	1458	1457	1456	1455	1454	1453	1452	1451	1450	1449	1448	1447	1446	1445	1444	1443	1442	1441	1440	1439	1438	1437	1436	1435	1434	1433	1432	1431	1430	1429	1428	1427	1426	1425	1424	1423	1422	1421	1420	1419	1418	1417	1416	1415	1414	1413	1412	1411	1410	1409	1408	1407	1406	1405	1404	1403	1402	1401	1400	1399	1398	1397	1396	1395	1394	1393	1392	1391	1390	1389	1388	1387	1386	1385	1384	1383	1382	1381	1380	1379	1378	1377	1376	1375	1374	1373	1372	1371	1370	1369	1368	1367	1366	1365	1364	1363	1362	1361	1360	1359	1358	1357	1356	1355	1354	1353	1352	1351	1350	1349	1348	1347	1346	1345	1344	1343	1342	1341	1340	1339	1338	1337	1336	1335	1334	1333	1332	1331	1330	1329	1328	1327	1326	1325	1324	1323	1322	1321	1320	1319	1318	1317	1316	1315	1314	1313	1312	1311	1310	1309	1308	1307	1306	1305	1304	1303	1302	1301	1300	1299	1298	1297	1296	1295	1294	1293	1292	1291	1290	1289	1288	1287	1286	1285	1284	1283	1282	1281	1280	1279	1278	1277	1276	1275	1274	1273	1272	1271	1270	1269	1268	1267	1266	1265	1264	1263	1262	1261	1260	1259	1258	1257	1256	1255	1254	1253	1252	1251	1250	1249	1248	1247	1246	1245	1244	1243	1242	1241	1240	1239	1238	1237	1236	1235	1234	1233	1232	1231	1230	1229	1228	1227	1226	1225	1224	1223	1222	1221	1220	1219	1218	1217	1216	1215	1214	1213	1212	1211	1210	1209	1208	1207	1206	1205	1204	1203	1202	1201	1200	1199	1198	1197	1196	1195	1194	1193	1192	1191	1190	1189	1188	1187	1186	1185	1184	1183	1182	1181	1180	1179	1178	1177	1176	1175	1174	1173	1172	1171	1170	1169	1168	1167	1166	1165	1164	1163	1162	1161	1160	1159	1158	1157	1156	1155	1154	1153	1152	1151	1150	1149	1148	1147	1146	1145	1144	1143	1142	1141	1140	1139	1138	1137	1136	1135	1134	1133	1132	1131	1130	1129	1128	1127	1126	1125	1124	1123	1122	1121	1120	1119	1118	1117	1116	1115	1114	1113	1112	1111	1110	1109	1108	1107	1106	1105	1104	1103	1102	1101	1100	1099	1098	1097	1096	1095	1094	1093	1092	1091	1090	1089	1088	1087	1086	1085	1084	1083	1082	1081	1080	1079	1078	1077	1076	1075	1074	1073	1072	1071	1070	1069	1068	1067	1066	1065	1064	1063	1062	1061	1060	1059	1058	1057	1056	1055	1054	1053	1052	1051	1050	1049	1048	1047	1046	1045	1044	1043	1042	1041	1040	1039	1038	1037	1036	1035	1034	1033	1032	1031	1030	1029	1028	1027	1026	1025	1024	1023	1022	1021	1020	1019	1018	1017	1016	1015	1014	1013	1012	1011	1010	1009	1008	1007	1006	1005	1004	1003	1002	1001	1000	999	998	997	996	995	994	993	992	991	990	989	988	987	986	985	984	983	982	981	980	979	978	977	976	975	974	973	972	971	970	969	968	967	966	965	964	963	962	961	960	959	958	957	956	955	954	953	952	951	950	949	948	947	946	945	944	943	942	941	940	939	938	937	936	935	934	933	932	931	930	929	928	927	926	925	924	923	922	921	920	919	918	917	916	915	914	913	912	911	910	909	908	907	906	905	904	903	902	901	900	899	8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While no definite value can be placed on the intangible benefits to the children and teachers in the way of increased knowledge and improved and preserved vision, the tests developed that good classroom lighting will pay for itself in dollars and cents.

NEW ORLEANS FACTS AND FIGURES:

In evaluating the effects of proper lighting in the schools of the city of New Orleans, the following should be considered:

1. In most schools, there is an insufficient amount of light, spotty illumination, glaring light sources.
2. The cause of many failures can be attributed to the fact that eyesight is neglected and lighting is inadequate.
3. Based upon the numerous tests conducted on "Lighting and Scholarship", these failures can be materially reduced through the installation of correct lighting.
4. Students who fail a course lose the total amount which they might have earned after finishing school for a period equal to the time required to repeat the course. While difficult to evaluate, this undoubtedly amounts to a considerable sum.
5. Light today is cheaper than ever before. Modern lighting equipment is more efficient. Adequate school lighting is, therefore, available at a smaller cost per pupil than ever before in history.

PSYCHOLOGY OF BETTER LIGHT:

Better light means brighter, more cheerful surroundings. This is invariably reflected in brighter, happier children. Also, consider the children who are actually backward, slow or reticent because of inability to see well. They grasp things more slowly and less completely. For this reason they are often looked down upon by their fellow-students and even by their teachers and parents. If better lighting can improve their conditions, think of the cases of inferiority complex, shyness, bashfulness and nervousness that might be alleviated. It is impossible to put a dollars and cents valuation on such a condition.

CONCLUSION:

Due to the natural and expected growth of the school system of New Orleans, tremendous progress has been made. Changed are the desks, the wall writing boards, the windows (both as to number and size),

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the window shades, the material with which the pupils work, their books, the heating methods, communication and period timing. All this fine modern plant calls for seeing - and seeing calls for light.

We sincerely desire that you obtain the greatest benefits from the use of our services. There is no cost to have your school surveyed for modern lighting. Our experienced lighting engineers will be glad to make a complete study of your lighting requirements, and place full details in your hands. May we help you?

The following is a list of the names of the persons who have been
admitted to the membership of the Society since the last meeting.
The names are given in alphabetical order.

Mr. J. H. Smith, of the City of New York, has been admitted to
membership. He is a member of the New York Society of Music and
has been a member of the Society for many years. He is a
very active member and has been a great help to the Society.
He is a very kind and generous person and has been a great
help to the Society in many ways. He is a very active member
and has been a great help to the Society in many ways.

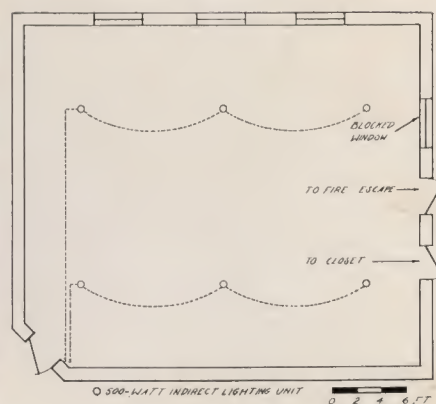
Lighting of a Classroom

In Accordance with the American Recommended Practice of School Lighting



View of Classroom

Installation at the Superior School,
Lambert and Superior Avenues,
East Cleveland, Ohio. June, 1938.



Plan of Classroom

The Lighting Problem: *To provide classroom illumination in accordance with the American Recommended Practice of School Lighting.*

General Information: The room is 28 feet x 32 feet in size, with a 12-foot ceiling. The ceiling is white and the walls are Nela light green, the latter with a reflection factor of approximately 50 per cent. All painted surfaces are flat finished. The window to the left of the fire escape door is permanently blocked. The pupils' desks are turned at an angle to the source of natural light.

Solution of the Lighting Problem: General illumination is provided by open luminous bowl pendent units, Wakefield "Commodore" with 18½ inch diameter plastic bowl, standard overall length of 34 inches, and 500-watt, inside-frost lamp. No lamp shields are used on the units as none of the lamp necks are visible.

The illumination in service on the desk tops is 20 foot-candles. The *American Recommended Practice of School Lighting* requires not less than 15 foot-candles in service on the desk and a brightness of the lighting unit of not more than 2.5 candles per square inch. Both of these requirements are met in the present installation.

Lighting data submitted by the F. W. Wakefield Brass Company as one solution of a lighting problem and to aid in the design of similar installations.

Distributed by the Committee on Lighting Service of the Illuminating Engineering Society,
51 Madison Avenue, New York, N. Y.

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